BACKGROUND

California's Transportation Issues

Since the early 1960s, California's population has grown by 89 percent. Although this trend has declined in recent years, past growth has put a real strain on the state's transportation system. The transportation system today is comprised of relatively unconnected segments and modes which are all too often out of balance with mobility needs. In many urban areas, systems are also severely over-saturated. This lack of capacity, balance and "connectivity," together with an almost exclusive reliance on petroleum as a fuel source, has contributed to a number of problems that adversely affect the mobility and economic well-being of Californians.

Traffic Congestion

Congestion is causing Californians hundreds of thousands of hours of delay resulting in billions of dollars of wasted fuel and lost productivity each year. Without effective new initiatives and programs, traffic congestion in California could increase by 200 percent in the next fifteen years. The level of mobility we came to depend on in years past can no longer be achieved with such an explosive congestion problem.

In addition to surface transportation, aviation in California has played an important role in the interregional movement of people and goods. Both the Federal Aviation Administration (FAA) and the California Aviation System Plan (CASP) project a significant increase in air passenger travel. This will add to the congestion in and around airports, which will continue to cause considerable delays for the traveling public.

Safety

Increased safety is one of the Department's most important goals. During 1994, more than 4,200 people died on California's streets and highways and another 316,000 were injured.

Despite a drop in the number of fatalities on U.S. highways, motor-vehicle accidents cost the nation more than $137 billion, according to the National Highway Traffic Safety Administration (NHTSA). Healthcare costs related to these accidents make up about 10 percent of that amount or $14 billion. Taxpayers pick up $3.7 billion of the health-care bill. Preventing many of the deaths and injuries on U.S. roads can reduce health-care costs by $1 billion each year. Improvements in highway safety will contain healthcare costs.

Significant gains in reducing costs have already been made by reducing the damage when collisions occur. The large future gains will come from collision avoidance. Vehicle innovations, such as Intelligent Transportation Systems (ITS) or "smart vehicle" technology, hold the key to future decreases in accident costs. Most collisions result from problems with a driver's behavior. The new technology can help adjust behavior more easily than an all-out promotional campaign designed to change basic behavioral problems. ITS will augment a driver's ability and correct for deficiencies.

There are 17,500 crashes each day in the United States. We save $35,000 for each serious motor-vehicle-crash injury prevented. For every dollar invested in highway safety, there is a $3 return.

NHTSA estimates that ITS can save 11,000 lives per year nationwide.

California's Transportation Issues

A significant increase in safety is a primary goal in the research and development of advanced technologies. New technologies as developed and described in this Advanced Transportation Systems Program document will contribute to a significant reduction in the number and severity of accidents and an increase in safety in rural and urban areas for Caltrans workers and the traveling public.

Energy

Transportation consumes 45 percent of the total energy used in California. It relies on petroleum fuels alone to satisfy more than 95 percent of its energy needs—a staggering 75 percent of the state's petroleum usage, according to the California Energy Commission (CEC). Because of these characteristics, transportation has been the hardest hit sector in past energy crises in terms of both price and supply. Energy policies in transportation have focused on improving vehicle and system efficiencies and increasing fuel and modal flexibility in order to protect the sector from future petroleum market disruptions.

Congestion contributes significantly to fuel efficiency losses. When average freeway speeds drop below 35 mph, fuel consumption increases because of the increased number of stops/starts. Congestion causes Californians to waste about 750 million gallons of fuel each year. This could increase to nearly 2 billion gallons within 15 years.

Providing for and accommodating safe and convenient non-motorized and mass transit modes will also contribute to energy use reductions.

Air Quality

California has experienced improved air quality during recent years, primarily due to cleaner burning engines and an increase in vehicle fuel economy. However, major efforts are still required to meet clean air standards. Since over 70 percent of air pollution in California still comes from the internal combustion engine, future major reductions in air pollution must come from: clean fuels and propulsion systems; implementation of transportation demand management strategies such as High Occupancy Vehicle (HOV) lanes, ridesharing, and congestion pricing; and, overall transportation system balance and efficiency. Strategies to improve air quality and to provide congestion relief are not incompatible, and can be implemented using many elements of ATS.

Economic Impacts

The annual cost of congestion to the state, in terms of lost productivity, lives, pollution and energy waste, is too high. Yet, these costs reflect only part of the danger to the state's economy from deteriorating levels of transportation service. The existing system is an impediment to California's economic vitality. Access to an effective and environmentally compatible mobility system is essential to a healthy economy. Transportation alone contributes nearly 60 percent of the gain in private sector output attributable to public sector infrastructure. California is the seventh largest economy in the world. Around the turn of the century, the annual value of goods and services will increase to some $800 billion. However, these estimates assume an adequate mobility system and the state effectively addressing its critical defense conversion challenge.

California's Challenges and Opportunities

The California Transportation Plan (CTP) implies that the major challenge facing California over the next 20 years is developing an accessible transportation system which complements and encourages a positive economy and a quality environment. The state cannot financially or environmentally support solely traditional approaches to transportation—building additional road capacity to solve congestion problems. This is particularly true because 60 percent of anticipated future demand for mobility services will be in the mature urban areas of the Los Angeles Basin and the San Francisco Bay Area. What is needed is a smarter transportation system, one that functions as an integrated intermodal system offering increased performance and expanded options for people and goods movement (including the option of substituting telecommunication for travel) and one that can incorporate clean fuel and propulsion systems.

California's opportunities to improve the transportation system have never been better. Recent state and federal laws have mandated new approaches to transportation funding and decision-making, emphasizing flexibility in pursuing the best transportation solutions, intermodalism, and broader participation by regional governments, local communities and the private sector. Stricter regulations demand environmentally-compatible transportation measures. In addition to this new foundation for governmental action, California enjoys a large and diverse industrial base in the technology fields. With declining national defense expenditures, industries involved in such work are actively pursuing civilian markets including transportation-related markets. Caltrans is committed to maximizing the benefits gained from the availability of human resources with advanced technical expertise during this time of conversion of California's technology from military to civilian emphasis. The "blue ribbon" panel of Project California, a joint effort of business, government and academia chartered by Governor Pete Wilson and the California Legislature, has identified advanced transportation technologies as a primary opportunity for industrial defense conversion.

More than $130 billion is spent annually statewide by transportation system users and providers. The development of new, advanced transportation systems will not only increase the effectiveness of this investment (vis-a-vis mobility), but will provide California companies with opportunities to develop and sell products and services worldwide. It will also create jobs and improve the quality of life for the citizens of California. Caltrans, through its ATS Program, is committed to contribute to such mobility enhancement and economic development. The strategy for realizing the advanced transportation technology vision is outlined in the ATS Program Overview section beginning on page 22.

As a key element in achieving Caltrans' Advanced Transportation Systems Vision, California will spend more than $280 billion in the next 20 years for improving and expanding the transportation infrastructure.

Departmental Mission and Program Goals

Program Goals

- **Enhance Transportation Services**
- **Improve Safety**
- **Reduce Energy and Environmental Impacts**
- **Support Economic Well-Being**

The program's charge is to research, develop, demonstrate, and deploy advanced technologies that can improve the mobility of people, goods, services, and information in the state. The economic importance of having a transportation system that offers the best possible movement of goods, services, information and people, particularly for a state with the international connections and stature of California, makes this an important goal of the program.

The program looks beyond conventional methods to explore ways to enhance and connect all modes of travel and respond to societal needs for improved environmental quality, increased safety and equitable service for all citizens. This will require forming new partnerships with others who possess the needed methods and/or resources, including all levels of government, academia and the private sector (see page 20). This charge recognizes Caltrans' responsibilities to shape and build a consensus for public policy that guides the future of transportation in California. This Program is, therefore, a key vehicle by which Caltrans carries out its state leadership role.

The program gives Caltrans an extremely promising avenue to pursue four major goals related to its mission:

Enhance Transportation Services

- Improve system productivity and reduce congestion and its associated costs;
- Increase the people-carrying capacity of existing systems through higher vehicle occupancies;
- Improve goods movement capacity and efficiency;
- Promote intermodalism through better connectivity between all transport systems and modes;
- Enhance system accessibility, convenience, comfort, reliability and equity for users at all income levels, in all geographical areas, and for those with special needs;
- Improve productivity and reduce costs related to system construction, operation and maintenance;
- Enhance the quality and availability of data required for the planning, development, operation and maintenance of transportation facilities and services;
- Enhance accessibility to products and services through improvements to transportation and travel substitution systems; and,
- Make transportation more affordable.

Improve Safety

- Reduce the number of fatalities and injuries that occur in transportation and transportation-related accidents;
- Improve the safety of private vehicles, public transportation and commercial vehicles, and of hazardous waste movements; and,
- Improve personal safety in the use, operation and maintenance of transportation facilities and services.

Reduce Energy and Environmental Impacts

- Reduce harmful vehicle emissions;
- Facilitate deployment of clean fuels and propulsion systems;
- Reduce energy use intensities for all transport modes and systems;
- Expand transportation demand management options and effectiveness; and,
- Promote overall environmental compatibility of transport systems.

Support Economic Well-Being

- Improve the economic efficiency of the transportation system for all its users, including operating agencies, fleet managers and individuals through the design, development and implementation of ITS;
- Make better use of existing facilities, reducing the need for construction of capital-intensive new systems. Maximize the use of national and other outside resources in the execution of the ATS Program;
- Optimize the use of scarce transportation resources;
- Support and demonstrate new institutional structures for technology development, transfer and deployment in California;
- Promote and facilitate a viable and profitable advanced transportation technology industry in California;
- Promote greater financial benefits for business through better system efficiency leading to a reduction in costs; and,
- Improve the competitiveness of California industries within the United States and world economies.

The ATS Vision

The vision of a more mobile, economically healthy society that preserves the qualities that make California a desirable place to live was articulated in "California Transportation Directions: Mobility for 2010." This document was developed at the beginning of the 1990s by Caltrans in consultation with the state's transportation stakeholders. It recognized that the economy; energy and land use policies; community values, and protection of the environment are all interwoven with transportation. It also acknowledged that the very concept of mobility was changing with technological advances, which allow mobility options to encompass the movement of information, as well as people and goods. Three basic conditions were defined to enable the state to realize the Mobility 2010 vision:

- Communities will wisely plan, develop and use their land;
- Transportation providers will wisely manage their systems; and,
- Transportation consumers will wisely use the system.

Advanced technologies can provide the tools by which these conditions are realized. From "smart vehicles" to advanced transportation management and information systems, technology can support wise decision-making by all mobility partners. In the near term, the program's products will provide transportation users with comprehensive information and modal services; coordinate and optimize freeway, street and transit operations; and allow for real-time ridesharing and other high-tech demand management strategies. The safety of travel will be significantly increased through advanced vehicle control products which enhance operator perception on a continuous basis, give warning of impending danger, and intervene with emergency control to prevent accidents. Fleet operators, including transit

providers, can improve productivity and safety and offer expanded services better tailored to their customers' needs. In the longer term, alternative transport systems would be deployed—from small neighborhood vehicles to automated and/or high-speed ground systems. As these technological building blocks are integrated, options for modal linking will expand. A new unified transportation system could emerge which optimally matches mobility needs with service provision and incorporates clean and efficient propulsion technologies. In the future, revolutionary telecommunication services will change the way Californians approach transportation, altering traditional views on the movement of people, goods and information. A significant part of the population will work at home. Offices and homes will be linked by interactive, multi-media networks to create virtual organizations. By the year 2005, there will be 300,000 video conference systems installed in California. Distance learning and remote health care via telecommunications will be commonplace, as will remote shopping and banking.

One scenario for the vision, therefore, will have a significant number of the California population teleworking, teleshopping and telebanking. When travel is necessary, a push of a button will determine when and how it can most efficiently be done given transportation system options, conditions and costs. Modal options would include a wide array of customized public transportation services that rival the personal automobile in convenience and connectivity. Another button executes the travel plan, alerting any public transportation modes involved. Roadway and public transportation pricing could be linked to each other in real-time (given system conditions, time of day, environmental objectives, etc.) and users automatically charged in one monthly bill. The commute itself might involve a number of modes, some automated, all seamlessly linked to make transfers painless and efficient.

A similar scenario would take place in goods movement, with truck, rail, air and maritime operations completely coordinated and integrated. For example, advanced fleet management and information technologies will allow fleet managers (trucking companies, paratransit services, transit providers, etc.) to optimally route and schedule vehicles given actual system conditions and provide for automated compliance with regulatory and other administrative requirements. Also, use of advanced technologies such as digital maps, global positioning systems, computers and wireless communications will enhance the ability of navigators of sea-going vessels to avoid colliding with other vessels in low visibility areas.

Achieving this vision will ultimately enable Californians to:

- **Travel with convenience and pleasure;**
- **Travel with multiple mode options;**
- **Travel at low cost;**
- **Travel with minimal impact on the environment;**
- **Travel safely;**
- **Develop successful transportation related businesses;**
- **Improve and replace travel using telecommunications technologies;**
- **Create new industries and jobs and provide a new model for developing and deploying technologies; and,**
- **Compete effectively in worldwide ATS markets.**

Roles and Responsibilities

Development and deployment of advanced transportation technologies and systems will require unprecedented levels of cooperation and coordination among all levels of government, the private sector and academia. Systems that provide seamless services across jurisdictions and modes are possible only with the full cooperation of all such jurisdictions and modal operators. So-called "intelligent" systems must rely on widespread use of commercial and consumer products that are compatible with smart public infrastructure. In fact, about 80 percent of intelligent transportation system deployment costs are projected to occur in the marketplace, with only 20 percent attributable to public expenditures (this is further discussed in the Fifteen-Year Deployment Overview section). The very nature of nontraditional ATS approaches demand substantial research and analysis, the kind academia is well suited to deliver. Realization of the vision, therefore, entails the following roles and responsibilities:

The **federal government** will provide national leadership, development funding (particularly during the high-risk phases of research and testing), regulatory support, and national compatibility standards. In addition, it will make federal-aid funding available for ATS deployment.

California **state government** will work in partnership with the federal government, providing leadership by keeping an emphasis and focus on mobility, safety, and environmental and other societal goals. Caltrans will support ATS joint efforts through administrative, legislative, regulatory and public policy initiatives. Caltrans will take the lead responsibility of ATS development and deployment efforts in California, and ensure that adequate state resources are made available for matching federal funding opportunities and for ATS activities of special importance to California (see discussion of state/national program relationships in the Realizing the Vision section). This public investment of resources should act as a trigger for private development.

As a major transportation system owner and operator, Caltrans, in addition to being a primary player within the general state role, will also be responsible for the testing, evaluation and deployment of ATS technologies on state transportation facilities and services.

To achieve a balanced and mutually beneficial system, Caltrans will coordinate its efforts with regional and local agencies and the transportation planning program process. Cooperative partnerships are the key element in the planning and programming of transportation. Cooperative planning is conducted in a coordinated and continuous manner to implement projects within the state. This cooperative effort involves development of the State Transportation Improvement Program (STIP) in coordination with the local transportation agencies' Regional Transportation Improvement Programs (RTIPs) being developed at the local level concurrently.

Regional and local governments will play critical roles in identifying ATS-related needs and opportunities specific to their areas, and testing and evaluating ATS technologies on their own systems.

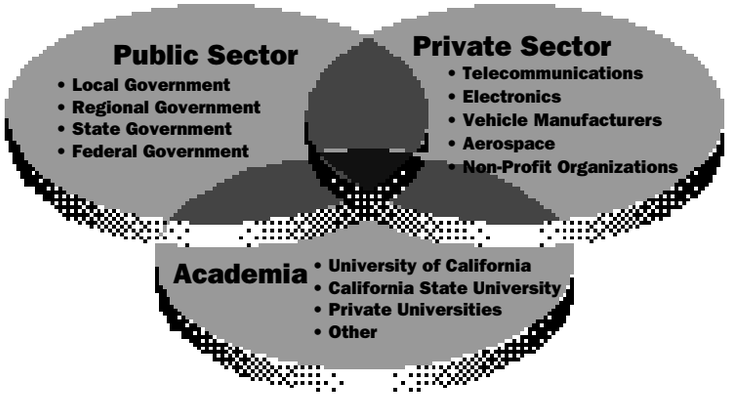
Roles and Responsibilities

Metropolitan Planning Organizations (MPOs), an integral part in this process, are responsible, through public participation and coordination with other agencies, for defining the transportation "problems" in their jurisdictions. In cooperative action with other groups and agencies, a "mix" of projects (e.g., transit, HOV, intelligent transportation technologies) are programmed to facilitate the safe and efficient movement of all transportation modes. Strategic plans for the early deployment of intelligent transportation systems are now being prepared by some MPOs as part of their regional transportation planning ensuring that ATS deployment is incorporated into the mainstream transportation planning and programming process.

The **private sector** will bring technology, manufacturing and marketing capabilities to the partnership. The private sector will provide a broad array of products and services to government, including: consulting; research and development facilities; computer software; specialized equipment; communications; system integration and deployment, and operational management support. In addition, the private sector will service the entire market side of ATS deployment in California, the nation and around the world.

Universities, national laboratories and professional societies will have a major involvement in research, development, testing, standards setting, training and technology transfer. The California Partners for Advanced Transit and Highways (PATH) Program was established in 1986, by Caltrans and the Institute of Transportation Studies at the University of California, Berkeley (UCB) to develop the foundations for the widespread adoption of advanced technologies that will help improve the operation of California's surface transportation systems. In order to develop these foundations, the PATH Program seeks to identify the impediments to progress, both technical and institutional, and develop strategies for overcoming those impediments. The PATH charter includes conducting leading-edge research, evaluating operational tests, developing public/private/academic partnerships, and educating both students and practitioners about ITS. However, it does not extend as far as deployment or operation of systems, which remain the responsibilities of Caltrans and the relevant local agencies.

Several other prominent California universities have joined in this statewide effort including University of California Davis (UCD), University of California Irvine (UCI), California Polytechnic State University, San Luis Obispo (Cal Poly), and the University of Southern California (USC).



ATS Program Overview

Program Scope

The Caltrans ATS Program provides the foundation for ATS efforts in California. As the state's transportation steward, Caltrans envisions the future of surface transportation as one of improved use of infrastructure and enhanced user choices through the application of advanced transportation technologies and services on the public infrastructure and in the marketplace. The ATS Program, therefore, incorporates technology applications in personal, public and commercial transportation, relevant to highway, rail, air or marine modes. It addresses state, local and private transport systems, within both urban and rural environments. The program pursues both supply- and demand-side measures. Most importantly, the program looks for opportunities to link individual system elements, and package measures to promote maximum system productivity.

The program recognizes that energy and environmental goals must be met in responding to mobility and safety needs. Caltrans envisions that the power and robustness of computer, electronic and telecommunication technologies will facilitate the development of transportation tools and packages that can form common solutions to multiple problems.

Program Principles

User Orientation - Program activities will focus on developing and delivering the user services described on pages 31-37.

Partnerships - Caltrans will seek to develop partnerships with other governmental agencies, academia and private industry in researching, developing, testing and deploying ATS technologies.

Education and Outreach - Caltrans will develop a dynamic outreach program to educate local and regional agencies about the value and appropriateness of incorporating new technologies into their planning efforts to assure timely and appropriate deployment throughout the state.

Respect For The Environment - Caltrans will work with others in the public and private sectors to research, develop, and evaluate technologies and systems with a view toward improving air quality, minimizing use of energy and otherwise benefiting the environment. The application of these new technologies must be done with respect for the environment, to eliminate any possibility that they might despoil or create negative secondary impacts.

Cost Efficiencies - A major objective of the ATS Program is to introduce new technologies that will facilitate new ways of doing business at reduced cost in transportation, planning, design, construction, operation and maintenance programs.

Leverage Of Program Investment - Pooling of resources from multiple sources can reduce costs to individual entities. Cost-sharing using available resources from federal, state, and local governments, academia, and the private sector is a guiding principle of the ATS Program.

All Modes Of Travel - The ATS Program takes a holistic approach to transportation technology opportunities, addressing all modes of transportation (surface, air, marine, motorized and non-motorized); and both supply enhancement and demand management approaches to mobility.

Building Block Development With Early Products - Technology deployment on the California transportation system will be achieved using a building block approach. Viable stand-alone technologies will be deployed when they can be shown to be cost-effective, and designed to integrate with other technologies into more powerful systems according to a "systems architecture." The systems architecture will be adopted on a national basis, allowing these systems to be deployed across state and national boundaries, to support a national ATS.

Support For Private Sector Commercialization - Caltrans' ATS Program will help lay the foundation for new product and service development in private markets. The ATS Program will work closely with private business to ensure the viability of these products and services, and their compatibility with technology deployments on the public infrastructure.

Deployment Planning - Caltrans ATS Program prepares and supports early deployment/strategic deployment planning to provide a bridge for new technology into the transportation decision-making process. This planning takes place in the urban and rural areas, addressing near, medium and long-term needs, goals and policies (see Early Deployment Plans and Southern California ITS Priority Corridor, pages 77-78).

ATS Program Overview

Program History

Since 1986, the ATS Program has built the foundation of a working partnership with a broad range of public and private interests. A primary partner of Caltrans has been the University of California's Institute of Transportation Studies, which helped in establishing the PATH Program to conduct research for Caltrans. Agencies of the federal government, such as the Federal Highway Administration (FHWA), the Federal Transit Administration (FTA), the National Highway Traffic Safety Administration (NHTSA) and the Federal Aviation Administration (FAA) are contributing to several projects under the Caltrans program. Numerous local and regional governmental agencies throughout California are participating with Caltrans in technology research. Non-profit organizations, including ride-sharing agencies, transportation management associations, auto clubs and the California Trucking Association are also participants. General Motors, Ford, Hughes Aircraft Company, TRW, Rockwell International, Southern California Edison and others, including some small businesses, are now private sector partners in the Caltrans technology program.

In addition, Caltrans is working closely with the California Energy Commission (CEC) and the State Air Resources Board on technology development. This cooperation recognizes the importance of addressing energy security and air quality goals in solving transportation problems, and the potential of advanced technologies to do so.

The California Highway Patrol (CHP) has also been a contributor in setting the technology research agenda, particularly as it relates to safety and traffic management. The California Public Utilities Commission (CPUC) is an active partner with Caltrans in testing "smart systems" for commercial trucking operations.

Working with other interested states and USDOT, Caltrans helped rekindle a national interest in technological solutions to growing congestion, safety and environmental problems. That interest resulted in the creation of the Intelligent Transportation Society of America (ITS America; formerly IVHS AMERICA) and the inclusion of a federal Intelligent Transportation Systems (ITS) program under ISTEA. Caltrans and many of its ATS partners in California are charter members of ITS America. As a strong supporter and leading player in the ITS national effort, Caltrans will focus on improving California's transportation system, while cooperating with a national program including the formation of a strong partnership in the Automated Highway System (AHS) demonstration and ATS systems architecture efforts.

The National Plan

USDOT and ITS America, working in cooperation with representatives of both the public and private sectors, have developed a National ITS Program Plan. User needs that can be addressed through ITS technologies and the services that are being developed or can be developed to meet those needs are identified in the plan. The plan will be used as a "road map" to determine how the interacting goals of industry, government, and users will be addressed in the development and deployment of ITS services in a nationally compatible, intermodal system. The plan represents a consensus view that the states, local governments and private industry can rely on for a vision of the ITS program across the country.

The Caltrans ATS Program Plan takes this process one step further to include the actual deployment of systems and technologies over a 15-year period.

Caltrans ATS Program

The Caltrans ATS Program has a number of distinguishing features:

- Strong emphasis on addressing safety, energy and environmental issues and goals;
- Strong emphasis on multimodalism in pursuing program goals;
- Advanced transportation system baseline for applying cutting-edge technologies;
- Rural applications of technology;
- World-class research program on vehicle control and robotics technologies for safety and automated operations, including facility maintenance and construction;
- An aggressive, safety-oriented Advanced Highway Maintenance and Construction Technology (AHMCT) Program designed to enable workers to safely and efficiently complete tasks with minimal impact on the traveling public;
- Participation in the National Automated Highway System Consortium (NAHSC), a nine-member cooperative effort funded by the Federal Highway Administration to design, construct and demonstrate a prototype of a working automated highway system in the United States by 2001; and,
- Program scope broader than ITS, incorporating new system concepts, high-speed ground systems and alternative vehicle technologies.

These distinguishing features and Caltrans' direct involvement in ITS America result in an ATS Program that will continue to keep California in a leadership position, taking advantage of program resources and products available nationally without duplicating efforts elsewhere.